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Moths and butterflies visiting flowers of *Anodendron affine* (Apocynaceae)

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Abstract We observed flower visitors of the woody climber *Anodendron affine* (Apocynaceae) in early March 2016 on the subtropical island Iriomotejima, southwestern Japan. Three butterfly, one moth, one bee, one wasp, one blowfly, and one hoverfly species were diurnal visitors, and four moth species were nocturnal visitors. All lepidopterans sipped nectar from the flowers. Flower visitation frequency was higher at night than in the daytime, although the observed daytime visitor diversity was higher. *A. affine* flowers attracted nocturnal moths more than other groups of insects.

Key words Erebidae, Iriomotejima, Pyralidae.

Introduction

Insects of the order Lepidoptera are well-known flower visitors, with adults using their proboscises to feed on nectar (Kevan and Baker, 1983). Because few researchers have observed nighttime flower visitors, flower-visiting behavior has been observed less frequently in moths than in butterflies (Hahn and Brühl, 2016). Flower-visiting moths can be categorized into two groups based on their morphology and behavior: (1) hawkmoths (Sphingidae) and (2) "settling" moths (e.g., Noctuidae, Pyralidae, and Geometridae; Bawa, 1990; Oliveira *et al.*, 2004; Atwater, 2013; Funamoto and Sugiura, 2016). Although hawkmoths have been investigated mainly in terms of moth-flower interactions, very few studies have focused on the interactions between flowers and settling moths (Bawa, 1990; Oliveira *et al.*, 2004; Hahn and Brühl, 2016).

Anodendron affine (Hook. and Arn.) Druce (Apocynaceae) is an evergreen vine found in Japan, Taiwan, China, Philippines, Thailand, Laos, Vietnam, Myanmar, and Bangladesh (Middleton, 1996). A previous study showed that butterflies were the main visitors of *A. affine* flowers in a warm temperate forest on the island Yakushima, southwestern Japan (Yumoto, 1987). However, the species names of the butterflies were not given, and observations were conducted only during the day (Yumoto, 1987). The flowers of *A. affine* are white to greenish yellow in color and moderately tubed (2.4-6.8 mm long) in morphology (Middleton, 1996). These floral traits are typically associated with settling moths (Willmer, 2011). Thus, we predicted that nocturnal settling moths, such as noctuids, would visit *A. affine* flowers. To test this prediction, we conducted nighttime observations of *A. affine* flowers on the subtropical island Iriomotejima, southwestern Japan. We also observed the flowers in the daytime to compare flower visitors and visitation frequency between daytime and nighttime.

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Materials and methods

Field observations were conducted in an evergreen forest in Uehara, Iriomotejima, Okinawa Prefecture, Japan (24° 40′ N, 123° 48′ E, 46 m above sea level). Three plant species, *A. affine*, *Bidens pilosa* L. (Asteraceae), and *Rhaphiolepis indica* (L.) Lindl. var. *umbellata* (Thunb.) H. Ohashi (Rosaceae), bloomed at this study site. We observed and/or collected insects visiting 82 inflorescences of an *A. affine* individual (148 total inflorescences) at 20:00-22:00 on 5 March 2016 (temperature, 21.2-21.9℃; wind speed, 1.4-3.0 m/s; weather condition, rainy; data from the Iriomotejima Meteorological Station), 13:00-14:00 on 6 March 2016 (25.0-25.3℃; 1.7-2.0 m/s; sunny), and 10:47-11:05 on 7 March 2016 (24.0℃; 3.6 m/s; sunny). Among the 82 inflorescences, 282 flowers opened. The mean ± SE of open flowers per inflorescence was 3.4 ± 0.6 (N = 82). We recorded the numbers and species names of flower visitors. Flower visitors were identified to species, genus, or family level in the field. The sampled insects were identified to species or genus level in the laboratory. We also measured the proboscis length of sampled insects using slide calipers. Because parts of insects could not be collected from *A. affine* flowers, their proboscis lengths were measured from individuals sampled at other locations. To investigate the relationship between flower tube length and insect proboscis length, we also measured corolla tube lengths, aperture diameters, and the distances from apertures to stamens of *A. affine* using slide calipers.

Results and discussion

Twelve species of insects were observed visiting the *A. affine* flowers. The diurnal visitors included three butterfly, one moth,

Table 1. Flower visitors of *Anodendron affine* on Iriomotejima in 2016.

Order	Family	Species	Number of individuals		Proboscis length mm
			Daytime	Nighttime	mean (N)
Lepidoptera	Choreutidae	*Choreutis cyanogramma* (Diakonoff & Arita)	1	0	4.0 (1)
	Pyralidae	*Endotricha olivacealis* (Bremer)	0	27	6.6 (5)
	Papilionidae	*Graphium sarpedon* (Linnaeus)	1	0	13.9 (1*)
		Graphium doson (C. & R. Felder)	1	0	13.0 (3*)
		Byasa alcinous (Klug)	3	0	18.1 (2*)
	Erebidae	*Brunia antica* (Walker)	0	4	6.7 (1)
		Nudaria ranruna Matsumura	0	2	3.9 (1*)
	Noctuidae	*Metaemene atrigutta* (Walker)	0	2	3.7 (1)
Hymenoptera	Scoliidae	Gen.	1	0	–£
	Halictidae	*Lasioglossum* sp.	5	0	0.6 (2)
Diptera	Syrphidae	*Episyrphus balteatus* (de Geer)	2	0	0.7 (1)
	Calliphoridae	Gen.	2	0	–£
Total			16	35	

* The proboscis length was measured from individuals sampled at other locations. *G. sarpedon* and *N. ranruna* were collected from Hyogo Prefecture, whereas *G. doson* and *B. alcinous* were collected from another island, Ishigakijima, Okinawa Prefecture.

£ The species could not be collected.

one bee, one wasp, one blowfly, and one hoverfly species, and the nocturnal visitors included four moth species (Pyralidae, Erebidae, Noctuidae) (Table 1). A pyralid moth, *Endotricha olivacealis* (Bremer), was the most abundant visitor to the *A. affine* flowers (Fig. 1 ; Table 1). On this basis, settling moths were the main nocturnal visitors of *A. affine* flowers. The daytime visitors were clearly different from the nighttime visitors (Table 1). Of the visitor species and individuals, 66.7% (8 of 12 species) and 80.4% (41 of 51 individuals) were lepidopteran adults, respectively (Table 1). All of the lepidopteran species visiting *A. affine* flowers had proboscises longer (3.7-18.1 mm; Table 1) than the corolla tube (mean length ± SE, 3.4 ± 0.3 mm, $N = 3$), thus enabling the moths and butterflies to sip nectar from the flowers. Other visitors (bees and hoverflies) had short mouthparts (length range: 0.6-0.7 mm; Table 1) and relatively large heads (width the range 1.9-2.0 mm), suggesting that they could not reach stamens or nectar (the mean distance ± SE from apertures to stamens, 1.6 ± 0.1 mm; mean aperture diameter ± SE, 0.9 ± 0.0 mm). For this reason, *A. affine* flowers attracted more lepidopterans than other groups of insects.

Fig. 1. A pyralid moth *Endotricha olivacealis* feeding on nectar from a flower of *Anodendron affine* on Iriomotejima in 2016.

More diverse visitors were observed in the daytime than at night (Table 1). The average number of visitor species per 100 open flowers per hour was 2.2 in the daytime and 1.4 at night. However, the flower visitation frequency was much higher at night than in the daytime. The average number of visitors per 100 open flowers per hour was 4.4 in the daytime and 12.4 at night. This suggests that *A. affine* flowers attracted more nocturnal moths than butterflies and diurnal moths, although additional studies are needed.

Flower-visiting moths have frequently been reported from several genera such as *Vincetoxicum* and *Metaplexis* in the family Apocynaceae (Sugiura and Yamazaki, 2005 ; Yamashiro *et al.*, 2008; Nakahama *et al*., 2013). Although a previous study showed that butterflies were the main flower visitors of *A. affine* (Yumoto, 1987), our nighttime observations clarified that nocturnal moths visited *A. affine* flowers more frequently than did butterflies and other daytime visitors (Table 1). This demonstrates that nighttime observations can clarify the

importance of nocturnal lepidopterans as flower visitors and/or pollinators (Hahn and Brühl, 2016).

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References

Atwater, M.M., 2013 . Diversity and nectar hosts of flower-settling moths within a Florida sandhill ecosystem. *J. Nat. Hist.* **47**: 2719-2734.

Bawa, K.S., 1990. Plant-pollinator interactions in tropical rain forests. *Annu. Rev. Ecol. Syst.* **21**: 399-422.

Funamoto, D. and S. Sugiura., 2016. Settling moths as potential pollinators of *Uncaria rhynchophylla* (Rubiaceae). *Eur. J. Entomol.* **113**, 497-501.

Hahn, M. and C.A. Brühl., 2016. The secret pollinators: an overview of moth pollination with a focus on Europe and North America. *Arthropod-Plant Interactions* **10**: 21-28.

Kevan, P.G. and H.G. Baker., 1983. Insects as flower visitors and pollinators. *Annu. Rev. Entomol.* **28**: 407-453.

Middleton, D.J., 1996. A revision of *Anodendron* A. DC. (Apocynaceae). *Blumea* **41**: 37-68.

Nakahama, N., R. Miura and T. Tominaga, 2013. Preliminary observations of insect visitation to flowers of *Vincetoxicum pycnostelma* (Apocynaceae: Asclepiadoideae), an endangered species in Japan. *J. Entomol. Sci.* **48**: 151-160.

Oliveira, P.E., P.E. Gibbs and A.A. Barbosa., 2004. Moth pollination of woody species in the central Brazil: a case of so much owed so few? *Plant Syst. Evol.* **245**: 40-54.

Sugiura, S. and K. Yamazaki., 2005. Moth pollination of *Metaplexis japonica* (Apocynaceae): pollinaria transfer on the tip of the proboscis. *J. Plant Res*. **118**: 257-262.

Willmer, P., 2011. Pollination and Floral Ecology. 778 pp., Princeton University Press, Princeton.

Yamashiro, T., A. Yamashiro, J. Yokoyama and M. Maki., 2008. Morphological aspects and phylogenetic analyses of pollination systems in the *Tylophora-Vincetoxicum* complex (Apocynaceae-Asclepiadoideae) in Japan. *Biol. J. Linn. Soc.* **93**: 325-341.

Yumoto, T., 1987. Pollination systems in a warm temperate evergreen broad-leaved forest on Yaku Island. *Ecol. Res*. **2**: 133-145.

摘　要

サカキカズラの花を訪れるチョウ・ガ類(阪上洸多・杉浦真治)

沖縄県西表島にてサカキカズラ（キョウチクトウ科)の花を訪れる昆虫の観察を行った．昼間にはチョウ類 3 種，ガ類 1 種，ハナバチ類 1 種，ツチバチ類 1 種，クロバエ類 1 種，ハナアブ類 1 種が，夜間にはガ類 4 種が観察され，チョウ・ガ類はすべて花から吸蜜していた．訪花昆虫の種数は昼間のほうが多かったが，訪花頻度は夜間により多かった．このようにサカキカズラの花は夜行性のガ類を主に誘引していた．

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